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Irrigation Costs and Returns

Cooperative Extension, South Dakota State University

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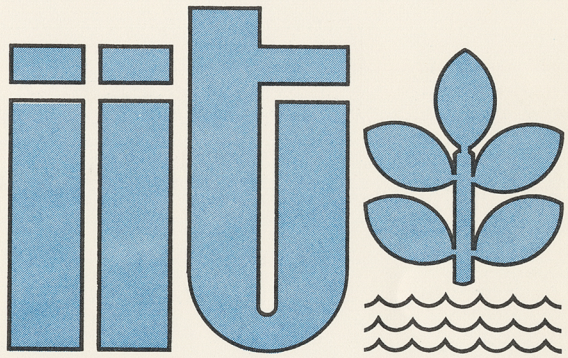

INSTITUTE OF IRRIGATION TECHNOLOGY

Cooperative Extension Service
South Dakota State University, Brookings
United States Department of Agriculture

IRRIGATION COSTS and RETURNS

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Dryland vs Irrigation
(An economic analysis of two different irrigation systems under conditions resembling central South Dakota, on 100 acres, using a well as the source of water)

CONTENTS

IRRIGATION can be profitable for farmers in South Dakota.

But successful irrigation farming requires above average farm management. Let us think of good farm management as the ability to make the right decision most of the time and to properly carry out the necessary cultural practices and farm business operations.

South Dakotans who are now irrigating crops and grassland usually give two reasons for going into irrigation farming.

First, they say, irrigation is really like **insurance** since it allows them to more accurately predict their income. South Dakota is a high risk area for crop production. Yields of all crops fluctuate annually due mainly to rainfall and weather variability. Irrigation is a means of satisfying crop water needs, thereby stabilizing crop yields. Livestock operations are more stable and profitable as feed grain and forage supplies are stabilized.

The second reason South Dakotans give for going into irrigation is the **possibility of greater direct net returns** from irrigated crops. Let's analyze this second reason more closely by comparing costs and returns of irrigation farming vs. dryland farming. Estimates of costs and returns are analyzed for four crops: corn for silage, corn for grain, alfalfa hay, and wheat. All costs and returns that affect net income are used to develop this analysis. By using these estimates and comparisons you should be able to better answer your question, "Will it pay me to invest in an irrigation system?"

For this comparison, let's assume that 100 acres of land are suitable for irrigation and the ground water is of desirable quality and quantity for irrigation. Assume that a 100-foot-deep well pumps up to 1,000 gallons per minute but that it could not be drilled in the center of the 100-acre field. In this case, the off-center well increases initial investment costs. Finally, assume 1968 prices.

NEW CAPITAL INVESTMENT REQUIRED

Total new investment costs are about $18,375 for a typical wheel move sprinkler system and $18,100 for a gated pipe gravity system for 100 acres. Table 1 summarizes costs for both systems. The estimated cost of

Table 1. Estimated Irrigation Investment Costs for 100 Acres of Irrigable Land, Central South Dakota, 1968

Cost Item	Estimated New Cost	
	Wheel Move Sprinkler	Gated Pipe Gravity
	Dollars	
100 foot well @ $24/ft	$ 2,400	$ 2,400
Gear head, pump, and motor		
39 brake horsepower	----	3,500
67 brake horsepower	4,500	----
Mainline and/or gated pipe	1,800	3,500
Wheel move sprinkler 1,290' @ $7.50/ft	9,675	----
Small land plane	----	1,200
Total land grading cost @ $75/acre	----	7,500
Total New Investment	**$18,375**	**$18,100**

$75 per acre for land grading includes charges for leveling and other shaping operations needed for control of water. Through current cost-sharing government programs the net cost paid by the farmer may be lower.

ANNUAL FIXED COSTS INCREASE

Annual fixed costs increase under irrigation in proportion to the investment required for your irrigation system. For the sprinkler irrigation system, added fixed costs are $2,102 as shown in table 2. For the gated pipe irrigation system added fixed costs are $1,691. Dividing these figures by 100 acres gives estimates of increases in per acre fixed costs: $21.02 for the sprinkler system and $16.91 for the gated pipe system.

In the dryland farming situation we will consider only estimated present real estate taxes of $20 ($2/acre) as fixed costs. A charge of $600 is used for a return on investment in land under both irrigated and dryland systems. Assume that this land charge represents about a 5% return on land value.

Total fixed costs are figured by adding estimated real estate taxes to the added irrigation system fixed costs: $23.02 for the sprinkler system and $18.91 for the gated pipe system, compared with $2 under dryland operation. Finally, whether the land is operated as dryland or under irrigation, part of the cost of operation is a return on the investment value of the land ($600 in this example).

Figure 1. Wheel move sprinkler irrigation system. Sometimes known as the side-move tow sprinkler system.

Figure 2. Gated pipe gravity irrigation system.

LABOR REQUIREMENTS

Labor required per acre for an irrigated unit will be 1½ to 2 times as high as for the same acreage operated as dryland. Table 3 shows labor requirements of 350 hours for a 100-acre dryland unit with 22 acres of corn for silage, 44.7 acres of corn for grain, 25 acres of alfalfa for hay, and 8.3 acres of wheat. This is 3.5 hours per acre and includes all normal farm operations. With a wheel move sprinkler system for the

Table 2. Fixed Annual Costs, Wheel Move Sprinkler and Gated Pipe Irrigation Systems, 100 Acres, Central South Dakota

Items	Wheel Move Sprinkler	Gated Pipe Gravity
	Dollars	
Interest on development investment*		
Sprinkler (3% of $18,375)	551.25	----
Gated pipe (3% of $10,600)	----	318.00
Land grading (6% of $7,500)	----	450.00
Depreciation		
Sprinkler (6.6% of $18,375)	1,212.75	----
Gated pipe (6.6% of $10,600)	----	699.60
Personal property tax and insurance		
Sprinkler (1.8% of $15,975)	287.55	----
Gated pipe (1.5% of $8,200)	----	123.00
Estimated added real estate tax		
Sprinkler ($0.50 per acre)	50.00	----
Gated pipe ($1.00 per acre)	----	100.00
Total Added Annual Fixed Costs	**$2,101.55**	**$1,690.60**
Present real estate taxes	200.00	200.00
Total Fixed Costs	**$2,301.55**	**$1,890.60**
Land charge (5% of $12,000)	$ 600.00	$ 600.00

*For investments that are depreciated interest was charged on average investment for the depreciation period, therefore for these items interest was charged at half the normal market rate. In this example the interest charge was based on a 6% market rate.

Table 4. Estimated Annual Operating Expense per acre, Dryland Operation, Wheel Move Sprinkler System, and Gated Pipe Gravity System, Central South Dakota

Description of Item	System of Operation: Dryland Operation	Wheel Move Sprinkler	Gated Pipe Gravity
Corn for Silage			
Fuel, oil, grease, repairs			
Field operations	$ 7.00	$10.00	$11.00
Irrigation system and pumping		8.10	4.80
Fertilizer; weed and insect chemicals	12.00	25.00	25.00
Annual charge for seed	2.50	5.50	5.50
Crop Insurance	2.00	4.80	4.80
6% interest on above costs	1.40	3.20	3.10
Fixed machinery charge	6.25	7.50	8.25
Total Operating Expense	**$31.15**	**$64.10**	**$62.45**
Expected average yield	8 T.	20 T.	20 T.
Charge for labor ($1.50 1 hr.)	$ 6.75	$ 9.00	$10.50
Corn for Grain			
Fuel, oil, grease, repairs			
Field operations	$ 5.25	$ 7.25	$ 8.25
Irrigation system and pumping		8.10	4.80
Fertilizer; weed and insect chemicals	10.40	19.80	19.80
Annual charge for seed	2.50	5.00	5.00
Crop Insurance	1.60	4.00	4.00
6% interest on above costs	1.20	2.65	2.50
Fixed machinery charge	5.00	5.75	6.50
Total Operating Expense	**$25.95**	**$52.55**	**$50.85**
Expected average yield	40 bu.	100 bu.	100 bu.
Charge for labor ($1.50 1 hr.)	$ 4.50	$ 6.75	$ 8.25
Alfalfa for Hay			
Fuel, oil, grease, repairs			
Field operations	$ 5.50	$ 7.75	$ 8.50
Irrigation system and pumping		8.10	4.80
Fertilizer; weed and insect chemicals	3.00	5.50	5.50
Annual Charge for Seed	1.10	1.75	1.75
Crop Insurance	1.20	3.20	3.20
6% Interest on Above Costs	.65	1.60	1.45
Fixed machinery charge	3.75	4.00	4.25
Total Operating Expense	**$15.20**	**$31.90**	**$29.45**
Expected Average Yield	1.9 T.	4.8 T.	4.8 T.
Charge for Labor ($1.50 1 hr.)	$ 6.00	$10.50	$12.30
Cash Wheat			
Fuel, oil, grease, repairs			
Field operations	$ 3.35	$ 3.50	$ 3.75
Irrigation system and pumping		4.30	2.55
Fertilizer; weed and insect chemicals	4.80	8.00	8.00
Annual Charge for Seed	2.60	2.75	2.75
Crop Insurance	1.00	2.00	2.00
6% Interest on Above Costs	.70	1.25	1.15
Fixed machinery charge	4.00	4.25	4.50
Total Operating Expense	**$16.45**	**$26.05**	**$24.70**
Expected Average Yield	20 bu.	40 bu.	40 bu.
Charge for Labor ($1.50 1 hr.)	$ 3.00	$ 4.50	$ 5.40

Table 3. Estimated Man Hours for Field Operation, Irrigation, Harvest and Hauling to Storage; Above Average Management Assumed: Central South Dakota

	Acres	Farming System		
		Dryland	Wheel Move Sprinkler	Gated Pipe Gravity
		Hours		
Corn for silage	22.0	99	132	154
Corn for grain	44.7	134	201	246
Alfalfa for hay	25.0	100	175	205
Wheat	8.3	17	25	30
Totals	**100.0**	**350**	**533**	**635**

same cropping pattern 533 hours are needed. The gated pipe system would require about 635 hours per year. These hours include all normal farm operations plus irrigating time, extra fertilizing time, grading time, hauling time, and other servicing time.

Irrigation can be a profitable way of using unemployed labor. If additional labor is not available, reconsider your irrigation plans.

OPERATING EXPENSES

All operating expenses increase when you change from dryland to irrigation farming. Operating expenses are broken down under six different headings in table 4.

Fuel, oil, grease, and repair costs of field operations for dryland farming are compared to irrigated farming costs. Added use of tractor for other machine field operations is necessary to prepare the ground for irrigation. The same group of costs for the irrigation system and pumping includes a charge for fuel and oil to pump water and for repairs on the irrigation system, pump, and motor.

Charges for fertilizer, weed control chemicals, and insect control chemicals are based on their being used at recommended rates. Seed costs are based on recommended seeding rates and the use of recommended varieties and top quality treated seeds.

Crop insurance represents a charge for hail insurance to cover the major part of cash expenses. With the higher cash outlay per acre, it may be advisable to consider insurance on the crop.

Money used for farming operations has probable value in some other use. To account for this opportunity cost a 6% interest charge on estimated cash expenses and the value of seed is used.

Machinery needed for the different crops and systems varies. The difference in this cost should be accounted for to fully analyze changes in costs of operation. Machinery charges in table 4 include depreciation, interest on investment, personal property taxes, and insurance for all machines used for each crop under each system.

Yields (over dryland) used in estimating operating costs and labor charges are shown in the table. For this example silage yields were increased 12 tons per acre by irrigation. Corn grain yields were expected to increase 60 bushels. Per acre yields increases were 2.9 tons for alfalfa and 20 bushels for wheat.

NOTE: In regard to estimated irrigated yields as shown in table 4, bear in mind that these are expected **averages** and probably lean toward the conservative side. Experienced managers are averaging yields at least 10% higher.

The last cost item estimated in table 4 is a charge for labor. Labor hours estimated in table 3 were charged to each crop at the rate of $1.50 per hour.

SUMMARY OF EXPECTED COSTS AND RETURNS

Expected gross income increases from $4,386 for dryland crops to $10,755 for the same crops under irrigation, an increase of $6,369. Acres of each crop, yields per acre, and prices per bushel or ton used for these estimates are shown in table 5. Note that expected yields were considered to be equal under both irrigation systems.

Table 5. Acres of Each Crop, Yield Per Acre, and Prices Used to Estimate Expected Gross Income, 100 Acres, Central South Dakota

Items	Crop Planted			
	Corn Silage	Corn Grain	Alfalfa Hay	Cash Wheat
Acres	22	44.7	25.0	8.3
Yield	(ton)	(bu.)	(ton)	(bu.)
Dryland	8	40	1.9	20
Irrigated	20	100	4.8	40
Price	$7.00	$1.10	$18.00	$1.60*

*Increase the value of the first 20 bushels by 40 cents per bushel to include the value of the wheat certificate program in effect in 1968.

To see whether or not irrigation pays we need to look at how total gross income is distributed. We can do this by allocating income to cover each type of cost. First, total operating costs for this cropping plan are $2,362 for dryland, $4,773 for the sprinkler irrigation system, and $4,588 for the gated pipe gravity system. These operating expense totals are calculated by multiplying acres of each crop (table 5) by total operating expense per acre (table 4).

Subtracting these costs from gross returns gives adjusted gross income (table 6) available to cover fixed costs, land charges, labor charges, and a return to management.

Returns to labor and management are $1,224 for the dryland plan, $3,080 for the sprinkler system, and $3,676 for the gated pipe system, after deducting total operating expenses, total fixed costs and a charge for land.

The actual return to the operator will vary depending upon how much of the total labor is hired labor.

Table 6. Summary of Expected Costs and Returns, Dryland and Irrigation, 100 Acres, Central South Dakota

Item	Dryland	Sprinkler	Gated Pipe
		Dollars	
Gross Market Value	4,386	10,755	10,755
Total Operating Expense	2,362	4,773	4,588
Adjusted Gross	2,024	5,982	6,167
Total Fixed Costs (table 2)	200	2,302	1,891
Return to Land, Labor and Management	1,824	3,680	4,276
Charge for Land (table 2)	600	600	600
Return to Labor and Management	1,224	3,080	3,676
Labor Charge ($1.50/hr.)	525	800	953
Return to Management*	**699**	**2,280**	**2,723**

*Based on acreage of each crop, yield per acre, and prices for production specified in table 5.

Putting a value of $1.50 an hour on all labor and subtracting this charge from returns to labor and management gives the return to management under each system. This return is $699 for dryland, $2,280 for the sprinkler system and $2,723 for the gated pipe system using the given yields and prices. Based on these estimates it appears that the sprinkler system can produce $1,581 more net income and give $275 more return to labor than dryland. The gated pipe system appears to have a potential of $2,024 more net income with a $428 higher return to labor. The higher net income $443 of the gated pipe system over the sprinkler system is mainly due to lower pumping costs.

A word of caution in regard to the gated pipe system: for a few years following land leveling, yields may not be as high as for the sprinkler system. This is due to removal of top soil from cut areas and excess compaction. However, with proper soil management, areas that were cut for leveling should be producing normally after about 3 years. Expected yields will then be the same for the gated pipe system as for the sprinkler system. Surface drainage obtained by leveling should easily make up for the adverse effects of leveling.

In these budgets the development of irrigation would pay for either system. With the relationship of costs shown it would be more profitable to use the gated pipe system if the land can be leveled without materially reducing longtime yields and if the extra labor is available.

BREAK-EVEN IRRIGATED CROP YIELDS

Yields needed to make irrigation at least as profitable as dryland farming can serve as a guide in deciding whether or not to develop irrigation on your farm. We will assume that the added costs for these two plans are representative situations. Added per acre yields needed can then be calculated.

Two types of costs need to be considered. First, look at added variable costs (operating costs and labor charges). After subtracting operating costs and labor charges for dryland crop enterprises from these same cost items for the identical crop enterprises under irrigation, we find that the increases in variable per acre costs range from $10.65 to $35.20 (table 7). What can these cost changes tell us?

If wheat is priced at $1.60 per bushel we need

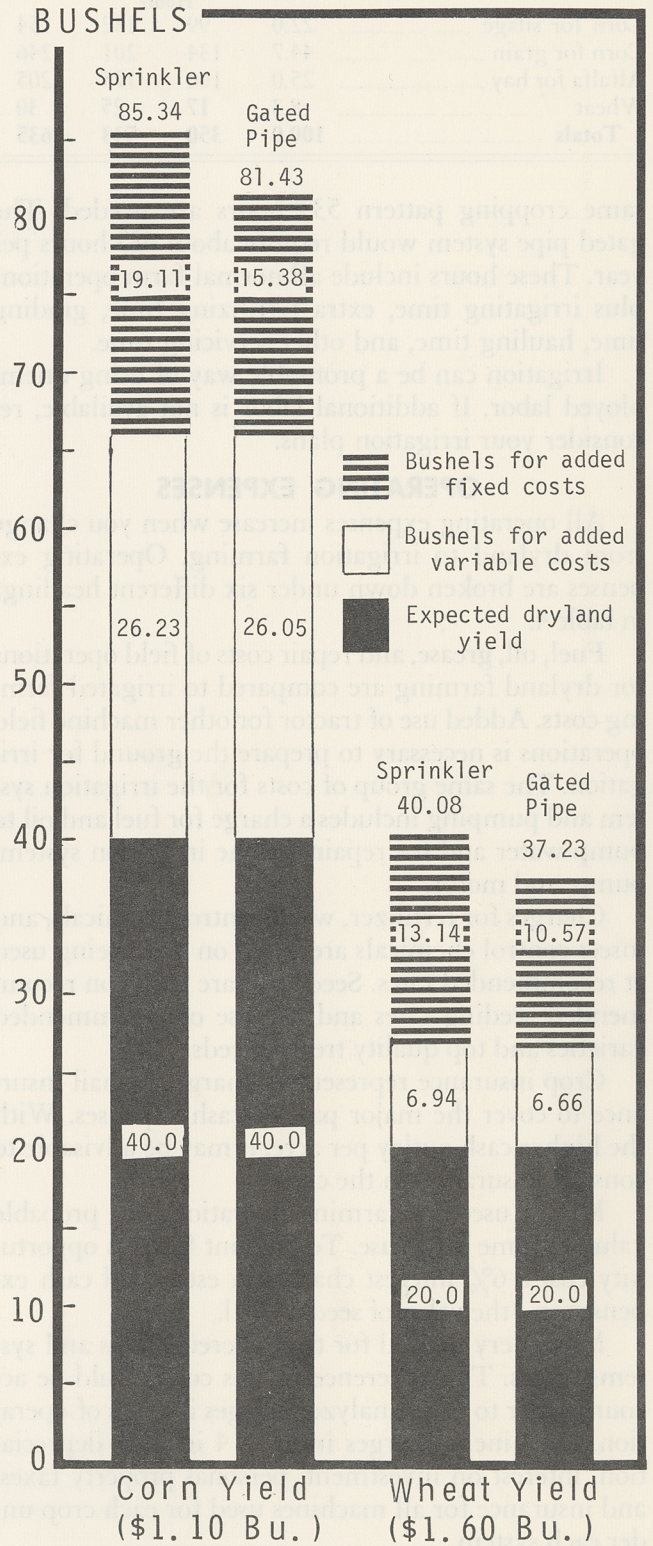

Figure 3. Grain yields needed to cover all added costs plus expected dryland yield.

about 6.7 bushels of wheat to pay the $10.65 of added variable costs incurred in irrigating wheat with a gated pipe system. With irrigated corn silage priced at $7 per ton, about 5 tons more silage per acre are needed to pay the $35.20 of added variable costs if the sprinkler system is used to produce corn silage. Other prices used to complete table 7 were $1.10 per bushel for corn grain and $18.00 a ton for alfalfa hay.

Second, we need to consider increased yields needed to cover added fixed costs or those that arise from developing and owning an irrigation system. Added annual fixed costs per acre for this sprinkler system are $21.02 per acre and added annual fixed costs per acre for this gated pipe system are $16.91. (See table 2 for the bases of these costs). Dividing both of these estimates by the price assumed for each crop gives increases in yields needed to cover added annual fixed costs. (See figures 3 and 4.)

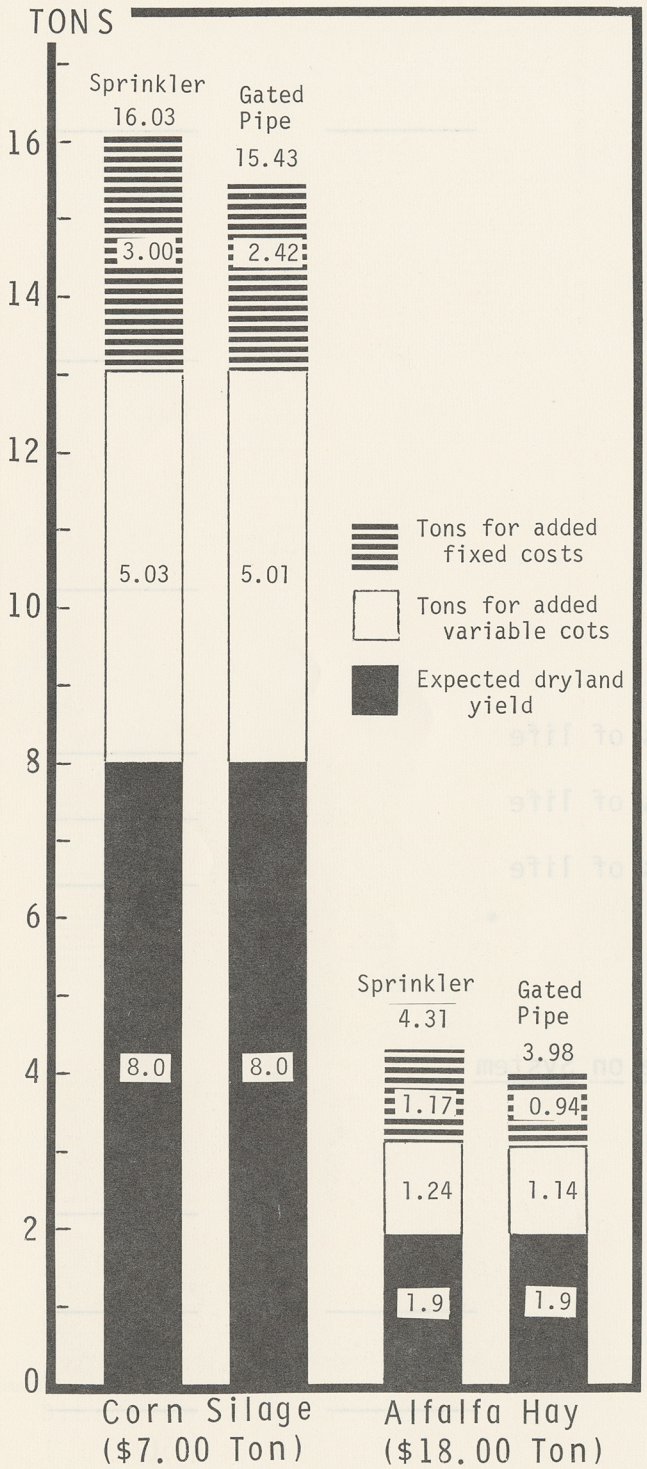

Figure 4. Forage yields needed to cover all added costs plus expected dryland yield.

Table 7. Added Variable Costs of Production and Increased Yields Needed to Cover These Added Costs, Central South Dakota, 1968

Crop	Wheel Move Sprinkler System		Gated Pipe Gravity System	
	Added Dollar Cost	Increase Needed In Yield	Added Dollar Cost	Increase Needed In Yield
Corn Silage	$35.20	5.03 T.	$35.05	5.01 T.
Corn Grain	28.85	26.23 bu.	28.65	25.05 bu.
Alfalfa Hay	22.20	1.24 T.	20.55	1.14 T.
Cash Wheat	11.10	6.94 bu.	10.65	6.66 bu.

Total irrigated yields needed to cover all added costs plus dryland yields are shown in figures 3 and 4. Dryland yields included in these graphs assure that returns to land and management will be at least as high under irrigation as for dryland. Bushels or tons needed to cover added variable costs are those calculated in table 7 and cover all new cash costs plus $1.50 per hour for additional labor needed for irrigated crops.

ESTIMATE YOUR OWN COSTS

Requirements for the acreage to be irrigated in a given case will vary from the average figures for the two systems discussed here. Before you make a decision to irrigate, you should budget out your own costs.

Any management decision to go into irrigation requires two steps. First, get an estimate of the initial cost of the system needed for your farm from an irrigation equipment dealer. The second step is to estimate annual costs for the system that he recommends. Three forms are provided in the following pages which you can use as guides in calculating your own costs and returns. Use these forms to estimate costs and returns for the crop that you most likely will irrigate.

Form 1. Refer to table 2 for additional information on items in this form.

Form 2. Refer to table 4 for estimated costs of production for corn for silage, corn for grain, alfalfa for hay and cash wheat. If you use these cost estimates, multiply each of them for the crop that you will irrigate by the acres in the field to be irrigated.

Form 3. Use this form to summarize added costs and calculate income and yield increases needed to pay for your irrigation system.

Form 1. Estimated Annual Fixed Costs of Irrigation Development and Land Investment. (Refer to table 2.)

	Dryland Operation	Irrigated Operation
Interest on Investment		
_____ acres of land valued at $_____ times _____% (rate of return - 5 to 7%)	_____	_____
Investment in Irrigation System		
$_____ times _____% (3 to 4%)		_____
Cost of Land Leveling		
$_____ times _____% (6 to 8%)		_____
Depreciation on Irrigation System		
$_____ divided by _____ years of life		_____
$_____ divided by _____ years of life		_____
$_____ divided by _____ years of life		_____
Taxes		
Personal Property Tax and Insurance on System		
$_____ times _____% (1 to 2% of new cost)		_____
Real Estate Taxes	_____	_____
TOTAL FIXED COSTS	_____	_____
ADDED FIXED COSTS (Irrigated minus Dryland)		_____

Form 2. Estimated Variable Costs of Operation, Dryland and Irrigated. (Refer to table 4.)

	Dryland	Irrigated
Fuel, Oil, Grease and Repairs		
Field operations	_____	_____
Irrigation system and pumping . . .		_____
Fertilizer, Weed and Insect		
Chemicals	_____	_____
Annual Charge for Seed	_____	_____
Sub-total.	_____	_____
Interest on Above Costs	_____	_____
____% (6 to 8%)		
Annual Machinery Charge		
(Depreciation, interest, taxes and insurance)		_____
Charge for Labor	_____	_____
TOTAL VARIABLE COSTS	_____	_____
ADDED VARIABLE COSTS (Irrigated minus Dryland)		_____

Form 3—A Summary

Line C shows total added gross value of crops needed to pay all added annual costs or charges.

On Line D, estimate the gross market value of the same crop if it is grown under dryland conditions.

Lines E, F, and G are analyses of what is needed to make irrigated crops as profitable as dryland crops. Line H is an estimate of the yield that you would expect under irrigation.

If the yield estimated on Line H is greater than the yield calculated on Line G, irrigation will pay on the field analyzed. If Line H is less than Line G, stability added to production would have to be worth enough to you to cover the difference between yield needed (G) and estimated average yield (H).

Summary of Total Costs of Production, Expected Yields and Cost Per Ton or Bushel Produced; Dryland, Wheel Move Sprinkler System, and Gated Pipe Gravity System; Central South Dakota

System of Farming	Cost Per Acre				Expected Yield	Cost Per Ton or Bushel
	Operating Expense	Fixed Cost	Labor Charge	Total		
Corn Silage						
Dryland	31.15	8.00	6.75	$ 45.90	8	$ 5.74
Wheel Move	64.10	29.01	9.00	$102.11	20	$ 5.11
Gated Pipe	62.45	24.91	10.50	$ 97.86	20	$ 4.89
Corn Grain						
Dryland	25.95	8.00	4.50	$ 38.45	40	$ 0.96
Wheel Move	52.55	29.01	6.75	$ 88.31	100	$ 0.88
Gated Pipe	50.85	24.91	8.25	$ 84.01	100	$ 0.84
Alfalfa for Hay						
Dryland	15.20	8.00	6.00	$ 29.20	1.9	$15.37
Wheel Move	31.90	29.01	10.50	$ 71.41	4.8	$14.88
Gated Pipe	29.45	24.91	12.30	$ 66.66	4.8	$13.89
Cash Wheat						
Dryland	16.45	8.00	3.00	$ 27.45	20	$ 1.37
Wheel Move	26.05	29.01	4.50	$ 59.56	40	$ 1.49
Gated Pipe	24.70	24.91	5.40	$ 55.01	40	$ 1.38

Form 3. Summary of Added Costs for Irrigation Farming and Total Gross Income Needed.

A. Added Fixed Costs (From Form 1) _____

B. Added Variable Costs (From Form 2) _____

C. Total Added Costs or Added Gross Value of Crops Needed (A + B) _____

D. Expected Gross Value of Crops From Dryland Farming

_____(acres) x _____(yield/acre)

x $_____(price/unit) _____

E. Total Gross Value of Crops Needed to Make Irrigation at Least as Profitable as Dryland (C + D) _____

F. Total Crop Production Needed to Equal Value in "E" (E divided by price per unit) _____

G. Yield Per Acre Needed (F divided by acres irrigated) _____

H. Your Estimated Potential Average Yield Per Acre Under Irrigation _____

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